IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Dingding Chen, et al	§	Confirmation No.:	7123
		§		
Serial No.:	10/600,991	§	Group Art Unit:	2129
		§		
Filed:	June 19, 2003	§	Examiner:	Buss, Benjamin J.
		§		
For:	PROCESSING WELL LOGGING DATA WITH NEURAL NETWORK	§	Attorney Docket No.:	1391-20308
		§		

APPEAL BRIEF

Mail Stop Appeal Brief - Patents Date: February 7, 2007

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

Appellant hereby submits this Appeal Brief in connection with the above-identified application. A Notice of Appeal is filed concurrently herewith.

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I. REAL PARTY IN INTEREST

The real party in interest in this matter is the assignee: Halliburton Energy Services, Inc.

II. RELATED APPEALS AND INTERFERENCES

Neither the appellant, the appellants' legal representative, nor the assignee know of any other appeals or interferences that will directly affect or be directly affected by or have a bearing on the Board's decision in an appeal on this case.

III. STATUS OF CLAIMS

The status of the claims is as follows:

Originally Filed:	1-25
Allowed:	13-19 and 21-25
Currently Rejected:	1-12 and 20
Presently Appealed:	1-9

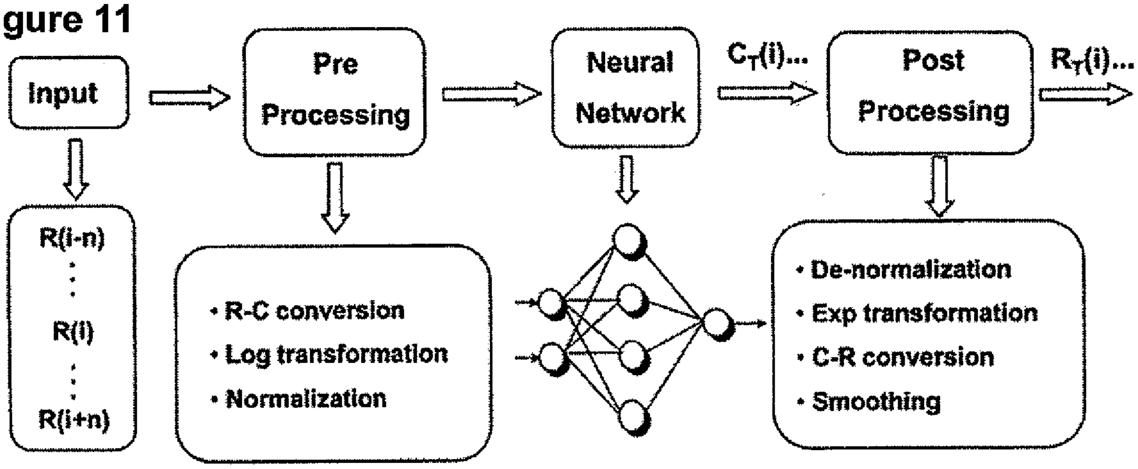
IV. STATUS OF AMENDMENTS

No amendments have been filed subsequent to the final office action.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The following provides a concise explanation of the subject matter defined in each of the claims involved in the appeal, referring to the specification by page and line number and to the drawings by reference characters, as required by 37 CFR § 41.37(c)(1)(v). Each element of the appealed independent claims is identified with a corresponding reference to the specification and drawings where applicable. Note that the citation to passages in the specification and drawings for each claim element does not imply that the limitations from the specification and drawings should be read into the corresponding claim element.

Figure 11



Claim 1 relates to an apparatus for converting output signals of a selected logging tool into a formation log (p1ℓ8-9; p2ℓ10-18; p15ℓ10-11). The apparatus includes an artificial neural network trained with a set of synthetic earth formation models selected to cover the operating range of the logging tool (Fig. 11; p9ℓ20-p10ℓ2; p13ℓ1-4; p16ℓ23-p17ℓ15; p21ℓ3-19). Specifically, the set of formation models is selected based on sensitivity and resolution limits of the logging tool in addition to being selected based on realistic ranges of formation parameters (*Id.*).

Claim 4, which depends indirectly from claim 1, recites a "means for combining the outputs of said neural network to generate an average value for each depth point in the borehole." In the specification, the corresponding structure that is expressly set forth is some part of a computer program that determines a mean or a weighted sum (p5ℓ22-p6ℓ6; p13ℓ14-15; Figs. 12-14; p24ℓ13-p27ℓ15). Of course, those of ordinary skill in the art will understand other structures to be within the scope of the disclosure and this claim limitation.

Independent claim 5 relates to a method for converting output signals of a logging tool into a formation log (p1ℓ8-9; p2ℓ10-18; p15ℓ10-11). The method includes creating a set of synthetic earth formation models selected to cover the operating range of the logging tool (p9ℓ20-p10ℓ2; p13ℓ1-4; p16ℓ23-p17ℓ15; p21ℓ3-19). Specifically, the set of formation models is selected based on sensitivity and resolution limits of the logging tool in addition to being selected based on realistic

ranges of formation parameters (*Id.*). The method further includes generating synthetic responses of the logging tool to each of the formation models, and using the synthetic responses and the formation models to train an artificial neural network to generate representations of the formation models in response to the synthetic responses (Fig. 4; p12ℓ22-p14ℓ11). Finally, the method includes processing actual logging signals from the logging tool with the trained neural network to produce a formation log (Fig. 11; p1ℓ8-9; p2ℓ10-18; p15ℓ10-11).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Applicants seek review of the following grounds of rejection:

Claims 1-3 and 5 stand rejected under 35 USC § 102(b) as being anticipated by US patent 5,862,513 ("Mezzatesta").

Claim 4 stands rejected under 35 USC § 103(a) as being unpatentable over Mezzatesta in view of U.S. Patent 5,210,691 ("Freedman").

Claims 6 and 9 stand rejected under 35 USC § 103(a) as being unpatentable over Mezzatesta in view of U.S. Patent 3,954,006 ("Anderson").

Claims 7 and 8 stand rejected under 35 USC § 103(a) as being unpatentable over Mezzatesta in view of U.S. Patent 5,184,079 ("Barber").

VII. ARGUMENT

The claims do not stand or fall together. Instead, applicants present separate arguments for various independent and dependent claims. After addressing a preliminary matter and a providing a concise discussion of the cited art, applicants present each of the separate arguments under corresponding headings and sub-headings as required by 37 CFR § 41.37(c)(1)(vii).

A. <u>Preliminary Matter</u>

Claims 1-4, 10-12, and 20 stand rejected under 35 USC §101, a ground of rejection that is not being appealed here. Applicants stand ready to amend the claims as suggested by the examiner

to overcome this rejection. After the prior art rejections are overcome, applicants propose that the following phrase be appended to independent claims 1, 10 and 20 by examiner's amendment: "wherein the artificial neural network is operable to process said output signals from the selected logging tool to produce said log". With this amendment, the rejected claims would recite a useful, tangible, and concrete result.

B. U.S. Patent No. 5,862,513 ("Mezzatesta")

Mezzatesta teaches systems and methods for forward modeling of logging tool responses (Title). Mezzatesta discloses a tool response inversion process in which an estimated model is updated until an optimal model is obtained (c1ℓ43-47). The updates are based on a comparison of the tool's actual measurements to a tool response calculated from the formation model (c1ℓ47-52). Mezzatesta proposes the use of a neural network to calculate the tool response from the formation model (Fig. 1A; c1ℓ66-c2ℓ5; c7ℓ44-59). To train the neural network, Mezzatesta teaches[1] that "a wellbore logging tool acquires an initial set of data for a … formation. A set of models or "training set" … for the formation is produced based on the original set of wellbore logging data" (c4ℓ8-14. *See also* c7ℓ35-43).

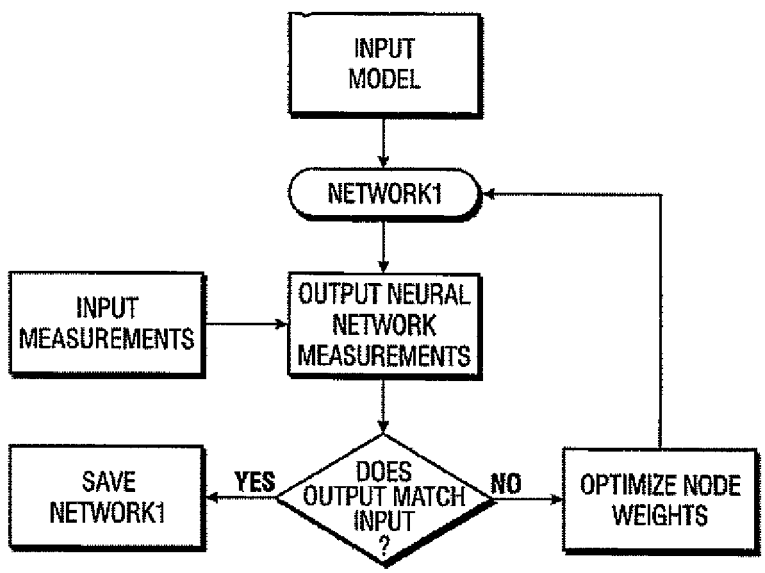


FIG. 1A

[1] Because the import of the cited language is disputed by the examiner, the full text is reproduced here and on the following page:

"In one aspect, in a method for training an ANN according to the present invention, a wellbore logging tool acquires an initial set of data for a number of points or areas in a formation. A set of models or "training set" (e.g. of actual and/or synthetic tool responses) for the formation is produced based on the original set of wellbore logging data for a single or multi-layer formation. The data may include numerous data points for each layer. An

C. U.S. Patent No. 5,210,691 (“Freedman”)

Freedman teaches a method and apparatus for producing a more accurate resistivity log from logging tool data (Title). Freedman’s method begins by dividing the formation around the borehole into pixels (c3ℓ17-21). The conductivity of each pixel is then determined iteratively (Fig. 7 (below), steps a3-a5; c3ℓ42-50). In each iteration, a theoretical tool response is calculated from the pixel conductivities and compared to the measured tool data (*Id.*). Based on the comparison, the pixel conductivities are updated to improve the agreement between the theoretical and actual measurements (c4ℓ2-5). In describing an illustrative application of his method, Freedman mentions that Fig. 12 shows results “obtained by combining data from both the ID [(deep induction)] and IM [(medium-depth induction)] arrays” (c14ℓ5-7). Though the precise meaning of this statement is unclear, it appears from the

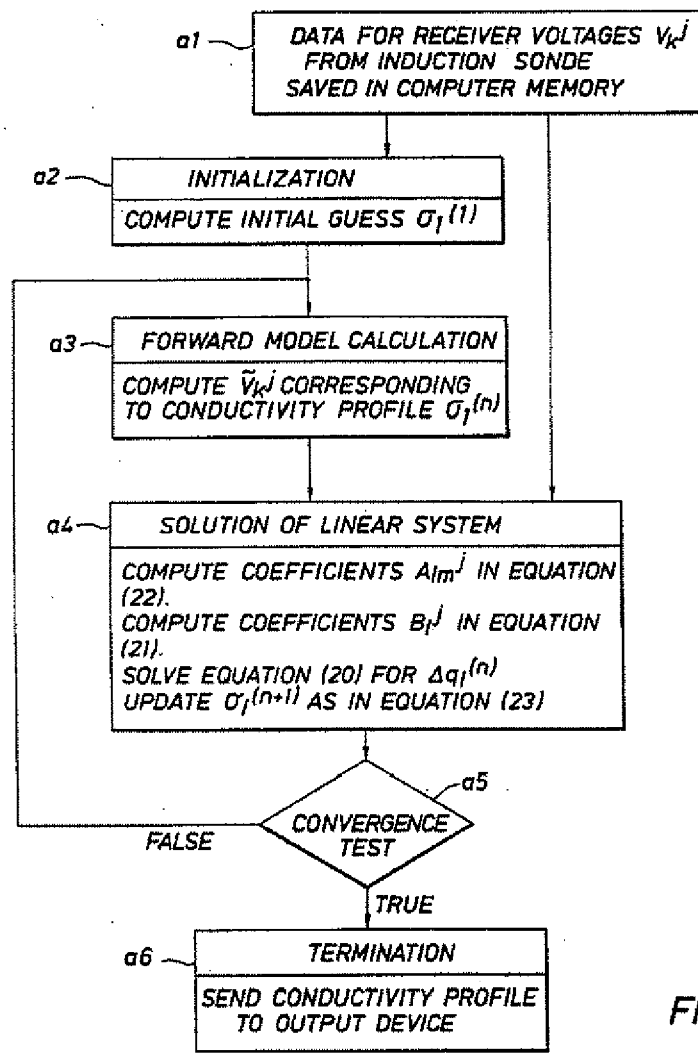


FIG.7

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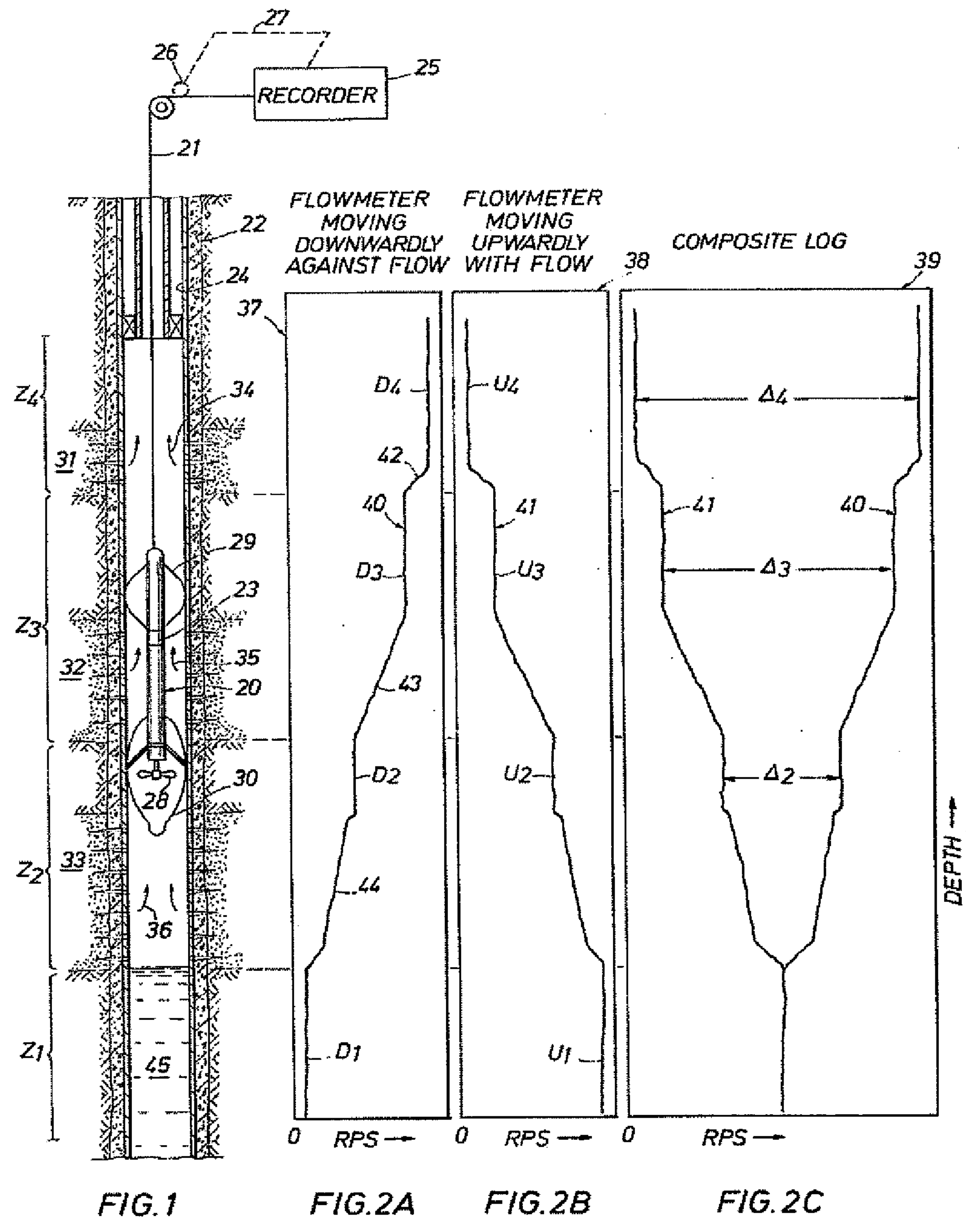
earth model or "input model" from the training set is then introduced to an artificial neural network ("ANN") to produce an output of predictive synthetic tool responses for a particular well logging tool.” (c4ℓ8-19)

“A well logging tool acquires data from a formation for an initial data set which is used to produce an earth model (which may be a group of models) ("INPUT MODEL"). Alternatively, based on known raw data obtained by a particular tool in various actual formations, an input earth model is produced that includes synthetic rather than raw data. Any known method or any method described herein may be used to produce the initial earth model.” (c7ℓ35-43)

context that Freedman is calculating and comparing theoretical responses for both the ID and the IM measurement arrays (c13ℓ66-c14ℓ15).

D. <u>U.S. Patent No. 3,954,006 ("Anderson")</u>

Anderson teaches methods of determining velocities and flow rates of fluids flowing in a well bore (Title). Anderson further teaches a composite log consisting of superimposed graphs of the data gathered during a downward traversal and an upward traversal of the flowmeter (Figs. 1-2C, below).



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E. **U.S. Patent 5,184,079 ("Barber")**

Barber teaches a method and apparatus to eliminate the effects of dip angle from data collected by an induction logging tool (Title; Abstract). In passing, Barber suggests that multiple coil array tools are known in the art (c8ℓ67-c9ℓ6).

F. **Anticipation by Mezzatesta**

Claims 1-3 and 5 stand rejected under 35 USC § 102(b) as being anticipated by US patent 5,862,513 ("Mezzatesta"). "To anticipate a claim, the reference must teach every element of the claim" (MPEP 2131). "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference" (Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987)). "The identical invention must be shown in as complete detail as is contained in the ... claim" (Richardson v. Suzuki Motor Co., 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989)). As explained for the different claim groups below, applicants respectfully traverse this ground of rejection because the cited art fails to teach every element of the claim.

1. ***Claims 1-3***

Independent claim 1 recites in part "an artificial neural network trained with a set of synthetic earth formation models selected to cover the operating range of a selected logging tool based on sensitivity and resolution limits of the logging tool and based on realistic ranges of formation parameters". The examiner cites Mezzatesta Fig. 1A and c3-9 (especially c3ℓ25-c6ℓ35, c7ℓ30-60, and c9ℓ35-55) as teaching these limitations. However, Mezzatesta's only specific teachings regarding the selection of a training set appear at c4ℓ8-15 and c7ℓ35-43. There Mezzatesta teaches that the training set is derived from well logging data acquired by a wellbore logging tool, though he does allow for the use of synthetic tool responses derived from the raw measurements (*Id.*). In other words, Mezzatesta teaches that his training set is based on an actual

formation rather than being selected to cover the operating range of the logging tool. For at least this reason, applicants maintain that the cited art fails to anticipate independent claim 1 or its dependent claims 2-3.

In the final office action, the examiner disputes applicants' interpretation of Mezzatesta. The examiner first asserts that "Mezzatesta discloses an earth model 'produced that includes synthetic rather than raw data' Mezzatesta (C7:30-60)" (p7ℓ180-181). However, the examiner's quote is taken out of context. The full sentence states "Alternatively, <u>based on known raw data obtained by a particular tool in various actual formations</u>, an input earth model is produced that includes synthetic rather than raw data" (c7ℓ38-41) (emphasis added).

The examiner next asserts that "Mezzatesta also discloses that the system/method results 'in a stable and accurate earth model for predicting formation parameters where actual raw logging data has not been obtained; Such systems which may be used at a well site or at a location remote from the well site; and Such systems and methods which use various different wellbore logging tools which process various types of wellbore logging data, which utilize a trained ANN [artificial neural network], and which provide a set of synthetic tool responses' (Mezzatesta C6:25-35)" (p7ℓ182-187). However, the quote itself indicates that this portion of Mezzatesta is directed to <u>the use of</u> the trained neural network to generate synthetic tool responses, and NOT to the data used to train the neural network as required by claim 1.

The examiner next asserts that "Additionally, Mezzatesta discloses that the synthetic data used to produce this synthetic model is based on known earth formations (C7:30-60) in the same manner that Applicant states in ¶57 of the Instant Application that one of the 'basic earth models used in the preferred embodiment … is referred to as an Oklahoma type formation because it is similar to real earth formations which occur in Oklahoma.'" (p7ℓ187-p8ℓ191). The relevance of this assertion to the claim language is unclear. The claims do not prohibit the use of models based

on known earth formations, but they do require "a set of synthetic earth formation models selected to cover the operating range of a selected logging tool", a limitation which is not taught or suggested by Mezzatesta.

Lastly, the examiner asserts that "Mezzatesta further discloses that these synthetic models generated are based on data from 'a particular tool in various earth formations' (Mezzatesta C70:30-60), therefore the model inherently takes the operating range of the tool into account" p8ℓ191-193. Applicants first note that claim 1 requires more that "taking the operating range of the tool into account" - specifically, claim 1 requires "a set of synthetic earth formation models selected to cover the operating range of a selected logging tool". Second, applicants note that the assertion of inherency must be grounded in the <u>necessity</u> of a limitation's presence.[2] It is by no means necessarily true that a given real earth formation will cover the operating range of a logging tool, or even that all portions of the earth formation will have a parameter within the operating range of the tool. Freedman, for example, demonstrates the effect of a tool's limited spatial resolution in Fig. 11, noting that in this frequently-used test problem, "The spurious oscillations in the inverted log are due to error amplification at the ID blind frequencies" (c14ℓ1-3). In other words, the cited art itself provides an example of models that fail to fall within the operating range of the logging tool, and hence demonstrates that the models are not selected based on the operating range of the tool.

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[2] "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.' " *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999) (citations omitted). "In relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic <u>necessarily</u> flows from the teachings of the applied prior art." *Ex parte Levy,* 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original).

The examiner concludes that the "broadest reasonable interpretation of Mezzatesta" anticipates the above-quoted limitation of claim 1. Applicants respectfully disagree, and for each of the reasons given above, respectfully request that this rejection be reversed.

2. *Claim 5*

Independent claim 5 recites in part "creating a set of synthetic earth formation models selected to cover the operating range of a selected logging tool based on sensitivity and resolution limits of the logging tool and based on realistic ranges of formation parameters". For the reasons argued above, Mezzatesta fails to anticipate this limitation.

In addition, claim 5 recites "train[ing] an artificial neural network to generate representations of the formation models in response to the synthetic responses". In contrast Mezzatesta employs a neural network to generate synthetic responses in response to the formation models (See e.g., Title; Abstract; Fig. 1A). In other words, Mezzatesta teaches the use of a neural network for forward modeling, whereas claim 5 recites a neural network for direct inversion of tool logging signals. For these reasons, applicants respectfully request that this rejection be reversed.

G. Obviousness of Claim 4 over Mezzatesta in view of Freedman

Claim 4 stands rejected under 35 USC § 103(a) as being unpatentable over Mezzatesta in view of U.S. Patent 5,210,691 ("Freedman"). Applicants respectfully quote the MPEP which recites in section 2142 (emphasis added by Applicants):

> To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. <u>Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations.</u>
>
> If the examiner does not produce a prima facie case, the applicant is under no obligation to submit evidence of nonobviousness.

(emphasis added). Applicants respectfully traverse this rejection because the cited art fails to teach or suggest all the claim limitations.

Claim 4 depends from claim 1, and thus incorporates the limitations of claim 1. Mezzatesta fails to teach or suggest each limitation of claim 1 as explained previously, and Freedman is silent with regard to neural networks. Claim 4 additionally recites "combining the outputs of said neural network to generate an average value for each depth point in the borehole". The examiner cites Freedman c3-17 (especially c13ℓ66-c15ℓ35) as teaching this limitation, and later cites c15ℓ20-35 as teaching combining data from different logs to obtain better resolution. While it is true that Freedman recites an inversion process "combining" induction logs with different depths of investigation to obtain better resolution, the "depths" in question are radial depths of investigation (c1ℓ29-31), which refers to the measurement of parameters at different distances from the center of the borehole. This "depth" does not correspond with the meaning of that term as it would be understood by one skilled in the art in light of the specification.[3]

The examiner further asserts "The person of ordinary skill in the art at the time of the invention would have found it obvious to combine the outputs of the ANN to produce such an average, since there is nothing novel about combining outputs of an ANN and it is routinely done by adding a single node output layer to the output of the ANN, the node performing the average" (p9ℓ240-244). There is certainly no support for this assertion in Mezzatesta or Freedman. Accord-

[3] "A chart or plot of an earth parameter or of a logging tool signal versus the position or depth in the borehole is called a 'log.' The depth may be the distance from the surface of the earth to the location of the tool in the borehole or may be true depth, which is the same only for a perfectly vertical straight borehole." Application p1ℓ32-p2ℓ2.

ingly, applicants respectfully traverse and call for the examiner to cite some support.[4] For the foregoing reasons, applicants respectfully submit that this rejection should be reversed.

H. Obviousness of Claims 6 and 9 over Mezzatesta in view of Anderson

Claims 6 and 9 stand rejected under 35 USC § 103(a) as being unpatentable over Mezzatesta in view of US patent 3,954,006 ("Anderson"). Claims 6 and 9 depend from claim 5 and thus incorporate the limitations of claim 5. Mezzatesta fails to teach or suggest each element of claim 5 as explained previously, and Anderson is silent with regard to neural networks. For at least these reasons, applicants respectfully submit that this rejection of claims 6 and 9 should be reversed.

I. Obviousness of Claims 7 and 8 over Mezzatesta in view of Barber

Claims 7 and 8 stand rejected under 35 USC § 103(a) as being unpatentable over Mezzatesta in view of U.S. Patent 5,184,079 ("Barber"). These claims depend from claim 5 and thus incorporate the limitations of claim 5. Mezzatesta fails to teach or suggest each element of claim 5 as explained previously, and Barber is silent with regard to neural networks. For at least these reasons, applicants respectfully submit that this rejection of claims 7 and 8 should be reversed.

VIII. CONCLUSION

In the course of the foregoing discussions, applicant may have at times referred to claim limitations in shorthand fashion, or may have focused on a particular claim element. This

[4] As stated by the court, "the precise language of 35 U.S.C. 102 … clearly places a burden of proof on the Patent Office which requires it to produce the factual basis for its rejection of an application under sections 102 and 103" (*In re Warner*, 154 USPQ 173, 177 (C.C.P.A. 1967), *cert. denied*, 389 U.S. 1057 (1968)). The examiner "can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references." *In re Fine*, 837 F.2d 1071, 1074, 5 USPQ 2d 1596, 1598 (Fed. Cir. 1988). The PTO "may not rest a prima facie case only on its own unsupported assertions." (*In re Ichihashi*, Civ. App. No. 93-1172, slip op. at 2–3 (Fed. Cir. Sep. 9, 1993) (unpublished)).

discussion should not be interpreted to mean that the other limitations can be ignored or dismissed. The claims must be viewed as a whole, and each limitation of the claims must be considered when determining the patentability of the claims. Moreover, it should be understood that there may be other distinctions between the claims and the cited art which have yet to be raised, but which may be raised in the future.

The Commissioner is hereby authorized to charge payment of any further fees associated with any of the foregoing papers submitted herewith, or to credit any overpayment thereof, to Deposit Account No. 03-2769, Conley Rose, P.C.

Applicants respectfully submit that the present application as amended is in condition for allowance. If the examiner has any questions or comments or otherwise feels it would be helpful in expediting the application, he is encouraged to telephone the undersigned at (713) 238-8055.

Respectfully submitted,

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IX. CLAIMS APPENDIX

1. (Previously presented) Apparatus for converting output signals of a logging tool into a log representing a parameter of earth formations surrounding a borehole, comprising:

an artificial neural network trained with a set of synthetic earth formation models selected to cover the operating range of a selected logging tool based on sensitivity and resolution limits of the logging tool and based on realistic ranges of formation parameters.

2. (Original) Apparatus according to Claim 1 wherein:

said logging tool output signals are a series of samples each representing the signal at a depth point in said borehole, and

said neural network has a plurality of inputs receiving the samples from a range of depths in the borehole and one output representing the parameter at a depth point within the range of depths.

3. (Original) Apparatus according to Claim 1 wherein:

said logging tool output signals are a series of samples each representing the signal at a depth point in said borehole, and

said neural network has a plurality of inputs receiving the samples from a range of depths in the borehole and a plurality of outputs representing the value of the parameter at a plurality of depth points within the range of depths.

4. (Original) Apparatus according to Claim 3, further comprising:

means for combining the outputs of said neural network to generate an average value for each depth point in the borehole.

5. (Previously presented) A method for converting output signals of a logging tool into a log representing a parameter of earth formations surrounding a borehole, comprising:

creating a set of synthetic earth formation models selected to cover the operating range of a selected logging tool based on sensitivity and resolution limits of the logging tool and based on realistic ranges of formation parameters;

generating synthetic responses of the selected tool to each of the formation models;

using the synthetic responses and the formation models to train an artificial neural network to generate representations of the formation models in response to the synthetic responses; and

processing actual logging signals from the selected tool with the trained neural network to produce a log of the earth parameter.

6. (Previously presented) The method of Claim 5, further comprising;

using the synthetic responses and the formation models to train one or more additional artificial neural network or networks to generate representations of the formation models in response to the synthetic responses;

processing the actual logging signals from the selected tool with the additional trained neural network or networks to produce an additional log or logs of the earth parameter; and,

combining the logs of the earth parameter to produce a composite log of the earth parameter.

7. (Original) The method of Claim 5, wherein the selected logging tool is an induction logging tool having more than one transmitter receiver pair and the synthetic responses from the selected tool include responses from more than one transmitter receiver pair.

8. (Original) The method of Claim 5, wherein the selected logging tool is an induction logging tool having both in-phase and quadrature output signals and the synthetic responses from the selected tool include both signals.

9. (Original) The method of Claim 5, wherein the artificial neural network has a plurality of outputs, each providing an output corresponding to a different depth point in the borehole, further comprising:

combining the plurality of outputs according to borehole depth points to produce a log of the earth parameter.

10. (Previously presented) Apparatus for converting output signals of a logging tool into a log representing a parameter of earth formations surrounding a borehole, comprising:

an artificial neural network trained with a set of synthetic earth formation models comprising;

a. a plurality of chirp models having continuously increasing layer thicknesses, each chirp model having parameter contrasts at layer interfaces limited to realistic contrasts found in actual earth formations, at least one model having an upper parameter limit substantially at the upper limit of the selected tool operating range, and at least one model having a lower parameter limit substantially at the lower limit of the selected tool operating range, and

b. a plurality of Oklahoma type models having parameter contrasts at layer interfaces limited to realistic contrasts found in actual earth formations, at least one model having an upper parameter limit substantially at the upper limit of the selected tool operating range and at least one model having a lower parameter limit substantially at the lower limit of the selected tool operating range.

11. (Original The apparatus of Claim 10, wherein:

the logging tool is an induction logging tool having a ratio of maximum sensitivity to minimum sensitivity of about 10,000 to 1 and the chirp models include at least one model with parameter contrasts at layer interfaces of about 10 to 1 and at least one model with parameter contrasts at layer interfaces of about 100 to 1.

12. (Original) The apparatus of Claim 10 wherein:

the logging tool is an induction logging tool having a ratio of maximum sensitivity to minimum sensitivity of about 10,000 to 1 and the Oklahoma models have parameter contrasts at layer interfaces from about 10 to 1 to about 100 to 1.

13. (Previously presented) A method for converting output signals of a logging tool into a log representing a parameter of earth formations surrounding a borehole, comprising:

creating a set of synthetic earth formation models comprising;

a. a plurality of chirp models having continuously increasing layer thicknesses, each chirp model having parameter contrasts at layer interfaces limited to realistic contrasts found in actual earth formations, at least one model having an upper parameter limit substantially at the upper limit of the selected tool operating range, and at least one model having a lower parameter limit substantially at the lower limit of the selected tool operating range, and

b. a plurality of Oklahoma type models having parameter contrasts at layer interfaces limited to realistic contrasts found in actual earth formations, at least one model having an upper parameter limit substantially at the upper limit of the selected tool operating range, and at least one model having an lower parameter limit substantially at the lower limit of the selected tool operating range;

generating synthetic responses of the selected tool to each of the artificial formation models;

using the synthetic responses and the formation models to train an artificial neural network to generate representations of the formation models in response to the synthetic responses; and

processing actual logging signals from the selected tool with the trained neural network to produce a log of the earth parameter.

14. (Original) The method of Claim 13, wherein:

the logging tool is an induction logging tool having a ratio of maximum sensitivity to minimum sensitivity of about 10,000 to 1 and the chirp models include at least one model with parameter contrasts at layer interfaces of about 10 to 1 and at least one model with parameter contrasts at layer interfaces of about 100 to 1.

15. (Original) The method of Claim 13 wherein:

the logging tool is an induction logging tool having a ratio of maximum sensitivity to minimum sensitivity of about 10,000 to 1 and the Oklahoma models have parameter contrasts at layer interfaces from about 10 to 1 to about 100 to 1.

16. (Previously presented) The method of Claim 13, further comprising;

using the synthetic responses and the formation models to train one or more additional artificial neural network or networks to generate representations of the formation models in response to the synthetic responses;

processing the actual logging signals from the selected tool with the additional trained neural network or networks to produce an additional log or logs of the earth parameter; and,

combining the logs of the earth parameter to produce a composite log of the earth parameter.

17. (Original) The method of Claim 13, wherein:

the selected logging tool is an induction logging tool having more than one transmitter receiver pair and the synthetic responses from the selected tool include responses from more than one transmitter receiver pair.

18. (Original) The method of Claim 13, wherein:

the selected logging tool is an induction logging tool having both in phase and quadrature output signals and the synthetic responses from the selected tool include both signals.

19. (Original) The method of Claim 13, wherein the artificial neural network has a plurality of outputs, each producing an output signal representing a different depth point in the borehole, further comprising:

combining the outputs of the neural network according to depth points to produce a composite log of a formation parameter.

20. (Previously presented) Apparatus for converting output signals of an induction logging tool into a log representing a parameter of earth formations surrounding a borehole, comprising:

an artificial neural network trained with a set of synthetic earth formation models comprising;

a. a plurality of chirp models having continuously increasing layer thicknesses, and having parameter contrasts of from about 10 to 1 to about 100 to 1 at layer interfaces, each model having different upper and lower parameter limits, selected so that the highest and lowest parameter limits are substantially at the upper and lower limits of the selected tool operating range, and

b. a plurality of Oklahoma type models having parameter contrasts of from about 10 to 1 to about 100 to 1 at layer interfaces, each model having different upper and lower parameter limits, selected so that the highest and lowest parameter limits are substantially at the upper and lower limits of the selected tool operating range.

21. (Previously presented) A method for converting output signals of an induction logging tool into a log representing a parameter of earth formations surrounding a borehole, comprising:

creating a set of synthetic earth formation models comprising;

a. a plurality of chirp models having continuously increasing layer thicknesses, and having parameter contrasts of from about 10 to 1 to about 100 to 1 at layer interfaces, each model having different upper and lower parameter limits, selected so that the

highest and lowest parameter limits are substantially at the upper and lower limits of the selected tool operating range, and

b. a plurality of Oklahoma type models having parameter contrasts of from about 10 to 1 to about 100 to 1 at layer interfaces, each model having different upper and lower parameter limits, selected so that the highest and lowest parameter limits are substantially at the upper and lower limits of the selected tool operating range;

generating synthetic responses of the selected tool to each of the artificial formation models;

using the synthetic responses and the formation models to train an artificial neural network to generate representations of the formation models in response to the synthetic responses; and

processing actual logging signals from the selected tool with the trained neural network to produce a log of the earth parameter.

22. (Previously presented) The method of Claim 21, further comprising;

using the synthetic responses and the formation models to train one or more additional artificial neural network or networks to generate representations of the formation models in response to the synthetic responses;

processing the actual logging signals from the selected tool with the additional trained neural network or networks to produce an additional log or logs of the earth parameter; and,

combining the logs of the earth parameter to produce a composite log of the earth parameter.

23. (Original) The method of Claim 21, wherein the selected logging tool has more than one transmitter receiver pair and the synthetic responses from the selected tool include responses from more than one transmitter receiver pair.

24. (Original) The method of Claim 21, wherein the selected logging tool provides both in phase and quadrature output signals and the synthetic responses from the selected tool include both signals.

25. (Original) The method of Claim 21, wherein the artificial neural network has a plurality of outputs, each producing an output signal representing a different depth point in the borehole, further comprising;

combining the outputs of the neural network according to depth points to produce a composite log of a formation parameter.

X. EVIDENCE APPENDIX

None.

XI. RELATED PROCEEDINGS APPENDIX

None.